DRAFT Total Maximum Daily Load (TMDL) For Fecal Coliform In The James Creek Watershed In the Tombigbee River Basin of Mississippi Lowndes and Noxubee Counties

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June 2007

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FOREWORD

This report has been prepared in accordance with the schedule contained within the federal consent decree dated December 22, 1998. The report contains one or more Total Maximum Daily Loads (TMDLs) for a water body segment found on Mississippi's 1996 Section 303(d) List of Impaired Water bodies in the Tombigbee River Basin. Because of the accelerated schedule required by the consent decree, many of these TMDLs have been prepared out of sequence with the State's rotating basin approach. The implementation of the TMDL contained herein will be prioritized within Mississippi's rotating basin approach. The amount and quality of the data on which this report is based are limited. As additional information becomes available, the TMDL may be updated. Such additional information may include water quality and quantity data, changes in pollutant loadings, or changes in landuse within the watershed. In some cases, additional water quality data may indicate that no impairment exists.

Conversion Factors

To convert from	To	Multiply by	To convert from	To	Multiply by
mile2	acre	640	acre	ft^2	43560
km2	acre	247.1	days	seconds	86400
m3	ft^3	35.3	meters	feet	3.28
ft3	gallons	7.48	ft3	gallons	7.48
ft3	liters	28.3	hectares	acres	2.47
cfs	gal/min	448.8	miles	meters	1609.3
cfs	MGD	0.646	tonnes	tons	1.1
m3	gallons	264.2	µg/l * cfs	gm/day	2.45
m3	liters	1000	µg/l * MGD	gm/day	3.79

Fraction	Prefix	Symbol	Multiple	Prefix	Symbol
10-1	deci	d	10	deka	da
10-2	centi	c	102	hecto	h
10-3	milli	m	103	kilo	k
10-6	micro	µ	106	mega	M
10-9	nano	n	109	giga	G
10-12	pico	p	1012	tera	T
10-15	femto	f	1015	peta	P
10-18	atto	a	1018	exa	E

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ID	Name	County	HUC	Cause	Monitored/Evaluated
MS031JE	James Creek	Lowndes, Noxubee	03160106	Pathogens	Monitored
From headwaters to the Tennessee-Tombigbee Waterway Segment begins north of Brooksville near Bigbee Valley and flows in a western direction					

Table ii. Water Quality Standard

Parameter	Beneficial use	Water Quality Criteria
Pathogens	Secondary Contact--Recreation	Pathogens Secondary Contact For the months of May-October (Summer Season), when water contact recreation activities may be expected occur, fecal coliform shall not exceed a geometric mean of 200 per 100 ml based on a minimum of 5 samples taken over a 30-day period with no less than 12 hours between individual samples, nor shall the samples examined during a 30-day period exceed 400 per 100ml more than 10% of the time. For the months of November–April (Winter Season), when incidental recreational contact is not likely, fecal coliform colony counts shall not exceed a geometric mean of 2000 per 100 ml based on a minimum of 5 samples taken over a 30-day period with no less than 12 hours between individual samples, nor shall the samples examined during a 30-day period exceed 4000 per 100 ml more than 10% of the time.

Table iii. Total Maximum Daily Load

Season	WLA (counts/day)	LA (counts/day)	MOS	TMDL (counts/day)	Percent Reduction
Summer	0.00	5.715×10^{10}	6.35×10^{9}	6.35×10^{10}	44%
Winter	0.00	7.983×10^{12}	8.87×10^{11}	8.87×10^{12}	0%

EXECUTIVE SUMMARY

James Creek (MS031JE) is on the Mississippi 2006 Section 303(d) List of Water Bodies as a monitored waterbody that is impaired due to pathogens (MDEQ, 2006). This TMDL addresses the pathogens impairment. An evaluated category indicates that the water body was listed based on anecdotal information and no additional monitoring data is available. This TMDL has been developed for James Creek from its headwaters to the confluence with the Tennessee-Tombigbee Waterway. The water body included in this TMDL is located within United States Geological Survey Hydrologic Unit Code 03160106, which covers Lowndes and Noxubee counties in the Tombigbee River Basin in Mississippi. The approximate length of James Creek is 11 miles and is a small, slightly sinuous stream with several small feeder streams. The James Creek drainage area is approximately 28.6 square miles. The impaired segment of James Creek is located within a rural watershed where the dominant land use is pasture.

Two of the four of the data sets collected at James Creek indicated impairment due to pathogens. EPA selected fecal coliform as an indicator organism for pathogenic bacteria as the State of Mississippi uses fecal coliform for monitoring and TMDL development. Due to data limitations, complex dynamic modeling was inappropriate for performing the TMDL allocations for this study, as were load duration curves.

Although fecal coliform loadings from point and nonpoint sources in the watershed were not explicitly represented with a model, a source assessment was conducted for the watershed. There are no active wastewater facilities permitted to discharge within the watershed; however, runoff from Concentrated Animal Feeding Operations (CAFOs) could cause or contribute to the impairment in James Creek. Nonpoint sources of fecal coliform include wildlife, agriculture runoff, and failing septic systems. The seasonal variations in hydrology, climatic conditions, and watershed activities are represented through the use of seasonal average flows and seasonal monitoring. Based on the available data, the critical condition was determined to be the summer season as violations of the instantaneous portion of Mississippi's water quality standards in James Creek occurred in the summer season.

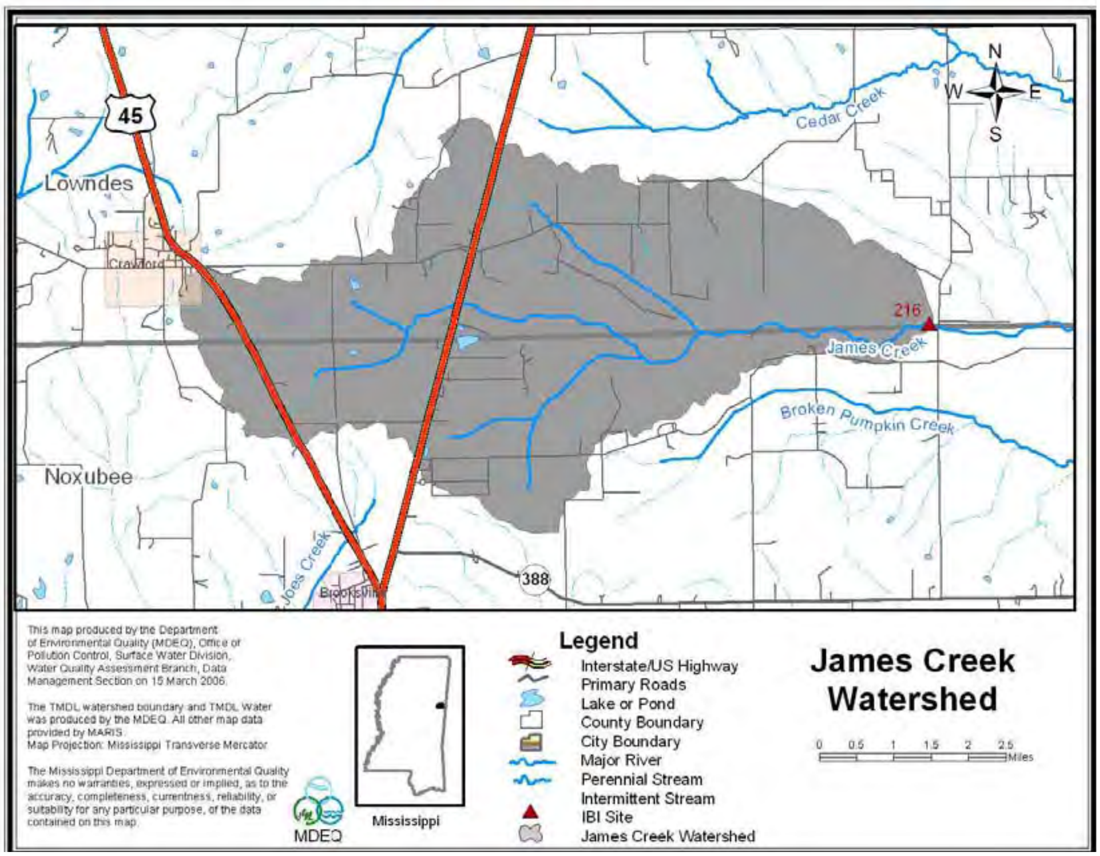
The percent reductions needed to attain water quality standards as well as the maximum daily loads were calculated for the Load Allocation for the summer and winter seasons. The Wasteload Allocation was set to zero for the summer and winter seasons as there are no point sources permitted to discharge to surface waters in the James Creek watershed. The CAFOs in the watershed are considered point source dischargers; however, the CAFOs are no discharge facilities. An explicit Margin of Safety was used in the TMDL, and is equal to 10 percent of the TMDL value. The estimated reduction of fecal coliform recommended by the TMDL for the summer season is approximately 44%. No reductions are needed for the winter season.

1.0 INTRODUCTION

1.1 Background

The identification of water bodies not meeting their designated use and the development of Total Maximum Daily Loads (TMDLs) for those water bodies are required by Section 303(d) of the Clean Water Act and the Environmental Protection Agency's (EPA) Water Quality Planning and Management Regulations (40 CFR part 130). The TMDL process is designed to restore and maintain the quality of those impaired water bodies through the establishment of pollutant specific allowable loads. The pollutant of concern for this TMDL is pathogens.

Figure 1. Location of the James Creek Watershed (map provided by MDEQ)



James Creek is within United States Geological Survey (USGS) Hydrologic Unit Code (HUC) 03160106. The James Creek watershed is located in Lowndes and Noxubee Counties in Mississippi's Tombigbee River Basin (see Figure 1). The entire watershed is 45.75 square miles and contains many landuse types including forest, pastureland, and wetland areas; however, the dominant landuse within the watershed is pasture. Landuse information is based on the State of Mississippi's Automated Resource Information System (MARIS), 1997. This data set is based on Landsat Thematic Mapper digital images taken between 1992 and 1993. The MARIS data are classified on a modified Anderson level one and two system with additional level two wetland classifications. The spatial distribution of landuse in the watershed is shown in Figure 2 and in tabular form in Table 1.

Figure 2. Landuse Distribution in the James Creek Watershed (map provided by MDEQ)

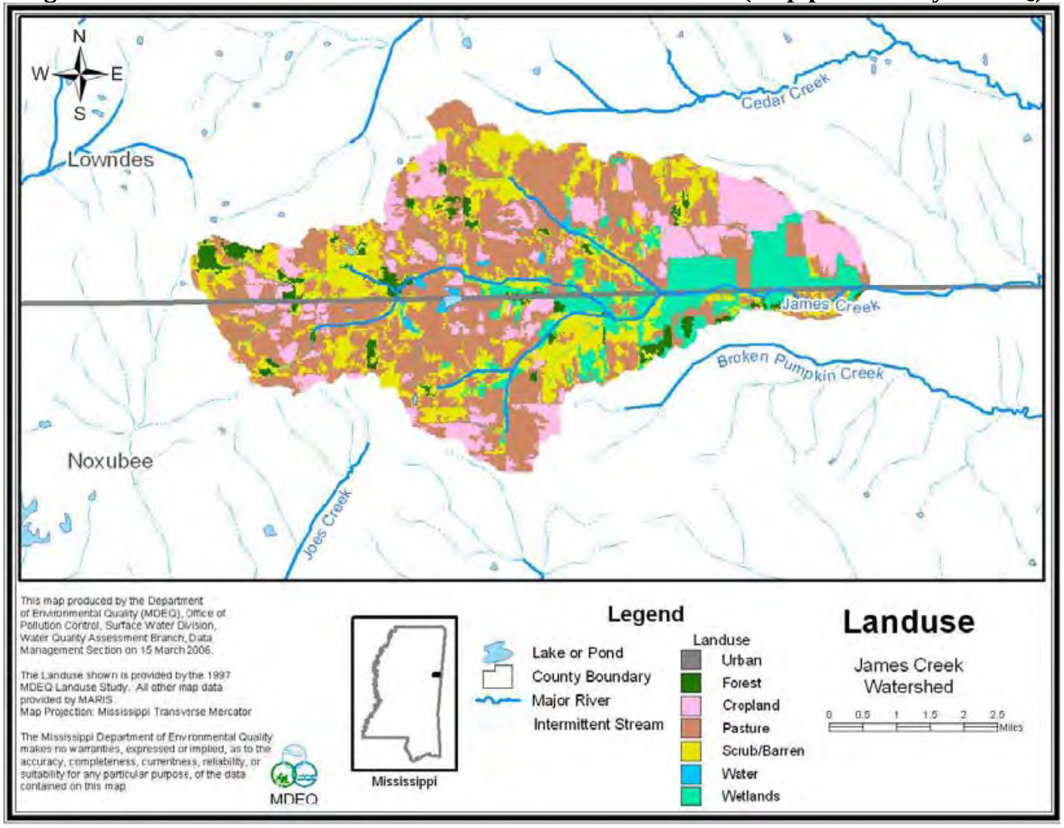


Table 1. Landuse Distribution in the James Creek Watershed and Riparian Zones

Landuse Land Cover	Entire Watershed (EW)		100m Buffer EW		100m Buffer 1km radius	
	Acres	%area	Acres	%area	Acres	%area
Urban	0	0%	0	0%	0	0%
Forest	673	4%	154	5%	2	3%
Cropland	2868	16%	171	5%	0	0%
Pasture/Grassland	8270	45%	1206	38%	19	25%
Scrub/Barren	4110	22%	935	29%	10	13%
Water	113	1%	36	1%	0	0%
Wetland	2269	12%	692	22%	46	60%
Total	18302	100%	3194	100%	78	100%

1.2 Applicable Water Body Segment Use

The water use classification for the listed segment of James Creek, as established by the State of Mississippi in the Water Quality Criteria for Intrastate, Interstate, and Coastal Waters regulation, is Fish and Wildlife Support (MDEQ, 2002). Waters with this classification are intended for fishing and propagation of fish, aquatic life, and wildlife. Waters that meet the Fish and Wildlife Support criteria should also be suitable for secondary contact, which is defined as incidental contact with water including wading and occasional swimming.

1.3 Applicable Water Body Segment Standard

The water quality standard applicable to the use of the water body and the pollutant of concern is defined in the State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters (MDEQ, 2003).

For the months of May-October (Summer Season), when water contact recreation activities may be expected occur, fecal coliform shall not exceed a geometric mean of 200 per 100 ml based on a minimum of 5 samples taken over a 30-day period with no less than 12 hours between individual samples, nor shall the samples examined during a 30-day period exceed 400 per 100ml more than 10% of the time.

For the months of November–April (Winter Season), when incidental recreational contact is not likely, fecal coliform colony counts shall not exceed a geometric mean of 2000 per 100 ml based on a minimum of 5 samples taken over a 30-day period with no less than 12 hours between individual samples, nor shall the samples examined during a 30-day period exceed 4000 per 100 ml more than 10% of the time.

2.0 TMDL ENDPOINT AND WATER QUALITY ASSESSMENT

2.1 Selection of a TMDL Endpoint and Critical Condition

One of the major components of a TMDL is the establishment of in-stream numeric endpoints, which are used to evaluate the attainment of acceptable water quality. In-stream numeric endpoints, therefore, represent the water quality goals that are to be achieved by implementing the load and waste load reductions specified in the TMDL. The endpoints allow for a comparison between observed in-stream conditions and conditions that are expected to restore designated uses. The fecal coliform standard allows for a statistical review of any fecal coliform data set. There are two tests, the geometric mean test and the 10% test, that the data set must pass to show acceptable water quality. The geometric mean test states that for the summer season the fecal coliform colony count shall not exceed a geometric mean of 200 per 100 ml based on a minimum of 5 samples taken over a 30-day period with no less than 12 hours between individual samples and for the winter season the fecal coliform colony count shall not exceed a geometric mean of 2000 per 100 ml based on a minimum of 5 samples taken over a 30-day period with no less than 12 hours between individual samples. The 10% test states that for the summer the samples examined during a 30-day period shall not exceed a count of 400 per 100 ml more than 10% of the time and for the winter the samples examined during a 30-day period shall not exceed a count of 4000 per 100 ml more than 10% of the time.

2.1.1 Discussion of the Geometric Mean Test

The level of fecal coliform found in a natural water body varies greatly depending on several independent factors such as temperature, flow, or distance from the source. This variability is accentuated by the standard laboratory analysis method used to measure fecal coliform levels in the water. The membrane filtration (MF) method uses a direct count of bacteria colonies on a nutrient medium to estimate the fecal level. The fecal coliform colony count per 100 ml is determined using an equation that incorporates the dilution and volume of the sample. The geometric mean test is used to dampen the impact of the large numbers when there are smaller numbers in the data set. The geometric mean is calculated by multiplying all of the data values together and taking the root of that number based on the number of samples in the data set.

$$\sqrt[n]{s1*s2*s3*s4*s5*sn}$$

The water quality standard requires a minimum of five samples be used to determine the geometric mean. The Mississippi Department of Environmental Quality (MDEQ) routinely gathers 6 samples within a 30-day period in case there is a problem with one of the samples. It is conceivable that there would be more samples available in an intensive survey, but typically each data set will contain 6 samples therefore, n would equal 6. For the data set to indicate no impairment, the result must be less than or equal to 200 in the summer and 2000 in the winter.

2.1.2 Discussion of the 10% Test

The 10% test looks at the data set as representing the 30 days for 100% of the time. The water quality standard requires that 90% of the time, the counts of fecal coliform in the stream be less than or equal to 400 counts per 100 ml in the summer and 4000 counts per 100 ml in the winter. Once the 90th percentile of the data set has been calculated, it may be compared to the standard of 400 counts per 100 ml. If the 90th percentile of the data is greater than 400 the stream will be considered impaired. Actual water quality data will typically have 5 or 6 values in the data set.

2.2 Discussion of the Targeted Endpoint

While the endpoint of a TMDL calculation is similar to a standard for a pollutant, the endpoint is not the standard. EPA has selected the 10% Test as the targeted endpoint for the TMDL as the Geometric Mean portion of the standard was not violated in any of the sampling seasons.

2.3 Discussion of the Critical Condition for Fecal Coliform

Based on the available data, the critical condition was determined to be the summer season as the violation of the 10% portion of Mississippi's water quality standards in James Creek occurred in the summer season.

2.4 Discussion of In-stream Water Quality

MDEQ conducted fecal coliform monitoring on James Creek at Station 303DF56, near Bigbee Valley at Plum Nellie Road in Lowndes County. Five data sets were collected, three in the summer and two in the winter seasons of 2001, 2002, 2003, and 2006. The data collected at Station 303DF56 on James Creek are provided in Table 2 through Table 6.

Table 2. Fecal Coliform Data, December 2001 and January 2002, Winter Season

Date	Time	Fecal Coliform (counts/100ml)	Geometric Mean	Geometric Mean Violation	90th Percentile	90th Percentile Violation
12/05/01	9:35	115	175.3	No	1620	No
12/07/01	9:25	110				
12/11/01	9:25	120				
12/18/01	10:30	2600				
01/02/02	10:45	42				

Table 3. Fecal Coliform Data, May 2002, Summer Season

Date	Time	Fecal Coliform (counts/100ml)	Geometric Mean	Geometric Mean Violation	90th Percentile	90th Percentile Violation
05/08/2002	8:55	200	84.6	No	716	Yes
05/13/2002	11:25	120				
05/15/2002	9:20	1060				
05/20/2002	11:35	100				
05/22/2002	11:45	12				
05/28/2002	11:10	12				

Table 4. Fecal Coliform Data, March and April 2003, Winter Season

Date	Time	Fecal Coliform (counts/100ml)	Geometric Mean	Geometric Mean Violation	90th Percentile	90th Percentile Violation
03/13/2003	9:25	35	92.3	No	632	No
03/26/2003	11:24	840				
03/31/2003	11:11	23				
04/02/2003	8:48	320				
04/04/2003	10:45	31				

Table 5. Fecal Coliform Data, July 2003, Summer Season

Date	Time	Fecal Coliform (counts/100ml)	Geometric Mean	Geometric Mean Violation	90th Percentile	90th Percentile Violation
07/28/2003	9:34	88	96.6	No	551.2	Yes
08/01/2003	9:28	19				
08/08/2003	9:22	860				
08/12/2003	9:30	69				
08/19/2003	8:48	85				

Table 6. Fecal Coliform Data, September 2006, Summer Season

Date	Time	Fecal Coliform (counts/100ml)	Geometric Mean	Geometric Mean Violation	90th Percentile	90th Percentile Violation
09/07/2006	12:14	21	68.5	No	211.5	No
09/14/2006	11:56	33				
09/19/2006	12:12	310				
09/21/2006	11:55	50				
09/25/2006	11:34	85				
09/28/2006	11:57	113				

There are two data sets that indicate exceedances of the water quality standard. They occur in the summer season of 2002 and the summer season of 2003. In both of these data sets the 90th percentile concentration exceeds the standard of 400 counts/100 ml 10% of the time. EPA calculated the 90th percentile by calculating the geometric mean for a given 30-day time period using data points that were log-normalized, which means that the natural log of each data point was generated. This process allows for the calculation of the 90th percentile from a normally distributed dataset using the standard deviation from this dataset. The 90th percentile was subsequently converted back using the natural exponent function and compared to the standard to determine if the standard was violated more than 10% of the time. Based on the data collected by MDEQ, the geometric mean test was not violated in any of the seasons.

On August 8, 2003, MDEQ collected a sample that caused a 2003 summer season violation of the fecal coliform standard. That sample was taken the day after a 4.13 inch rainfall event on August 7, 2003 measured at Columbus, MS rainfall gage #1880 of the National Weather Service Cooperative Observation Network. EPA's guidance for bacteria does not recommend data collection during and after rain events. However, the designated use and criteria still apply to James Creek. Without additional information and analysis, a TMDL for fecal coliform is needed for James Creek as the data indicates a violation of water quality criteria during the summer 2002 season.

3.0 SOURCE ASSESSMENT

An important part of the TMDL analysis is the identification of source categories, source subcategories, or individual sources of pollutants in the watershed and the amount of loading contributed by each of these sources. Sources are broadly classified as either point or non-point sources. Fecal coliforms enter surface waters from both point and non-point sources.

A point source is defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. Point source discharges of industrial wastewater and treated sanitary wastewater must be authorized by National Pollutant Discharge Elimination System (NPDES) permits. NPDES permitted facilities also include certain urban stormwater discharges such as municipal separate stormwater systems (MS4) areas, certain industrial facilities, and construction sites over one acre that are stormwater driven point sources. NPDES permits are also required for concentrated animal feeding operations (CAFOs).

Non-point sources of pollution are diffuse sources that cannot be identified as entering a waterbody through a discrete conveyance at a single location. These sources generally, but not always, involve accumulation of bacteria on land surfaces that wash off as a result of storm events. A geographic information system (GIS) tool was used to display, analyze, and compile available information to characterize potential bacteria sources in the impaired water body.

3.1 Assessment of Point Sources

A wasteload allocation (WLA) is given to all NPDES facilities in the watershed permitted to discharge to surface waters. Under the NPDES program, permits for wastewater facilities may authorize a discharge only if the applicant provides reasonable assurance that the discharge will not cause or contribute to violations of the water quality criteria. There are no wastewater or industrial NPDES facilities in the James Creek watershed permitted to discharge to surface waters.

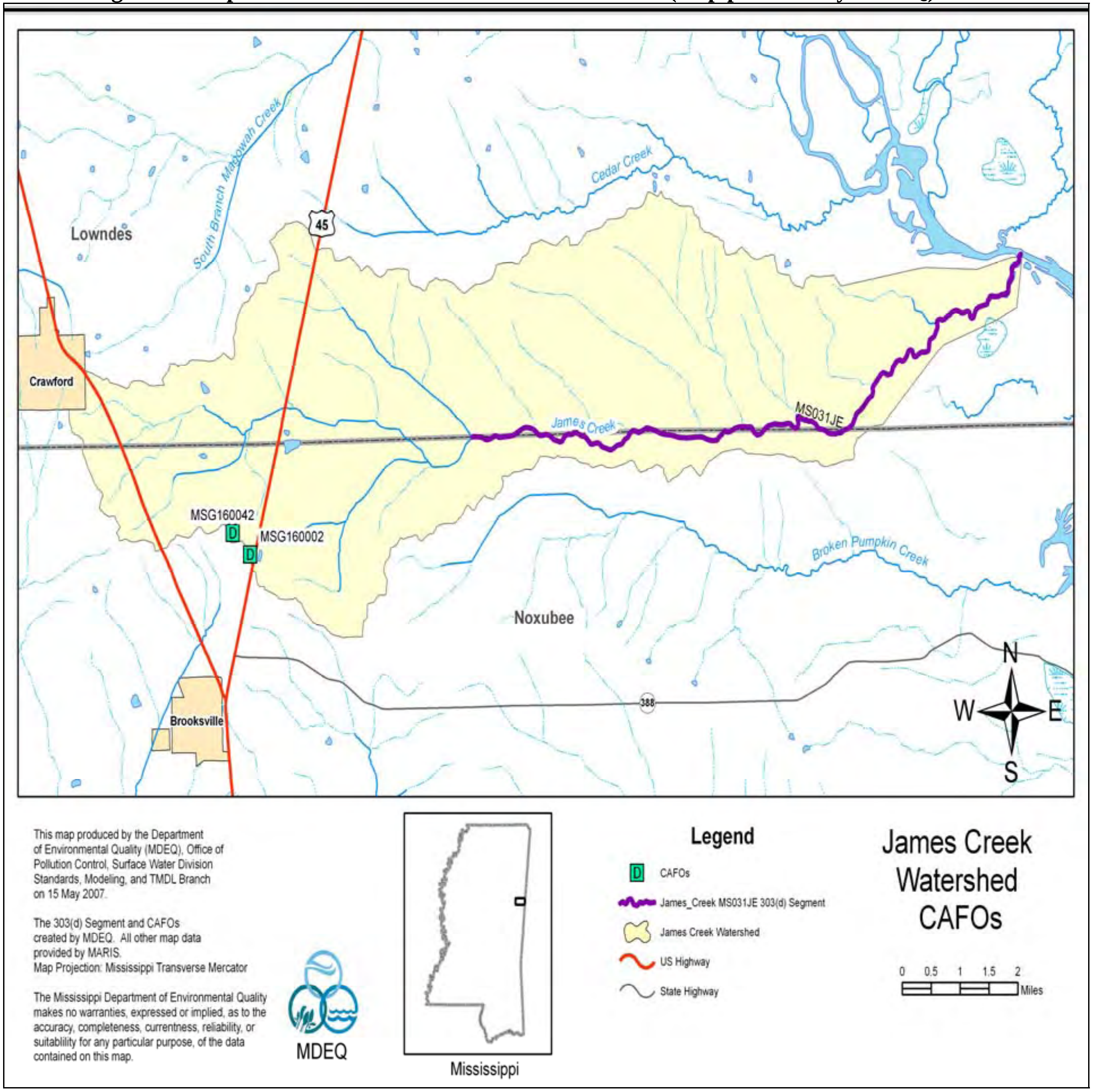
MS4s may also discharge fecal coliforms to waterbodies in response to storm events. Large and medium MS4s serving populations greater than 100,000 people are required to obtain a NPDES storm water permit under the Phase I storm water regulations. After March 2003, small MS4s serving urbanized areas were required to obtain a permit under the Phase II storm water regulations. An urbanized area is defined as an entity with a residential population of at least 50,000 people and an overall population density of 1,000 people per square mile. There are no municipalities in the watershed of sufficient population or density requiring MS4 permits.

CAFOs are point sources, as defined by the CWA [Section 502(14)]. To be considered a CAFO, a facility must first be defined as an Animal Feeding Operation (AFO) agricultural operation where animals are kept and raised in confined situations. AFOs generally congregate animals, feed, manure, dead animals, and production operations on a small land area. Feed is brought to the animals rather than the animals grazing or otherwise seeking feed in pastures. Animal waste and wastewater can enter creeks from spills or breaks of waste storage structures (due to accidents or excessive rain), and non-agricultural application of manure to crop land.

In the Tombigbee River Basin, processed manure from confined hog operations is collected in lagoons and routinely applied to pastureland according to the management practices used in the area. The amount of the manure application is determined by the nitrogen uptake of the plant being sprayed. The frequency is determined by rain events so that the waste is not sprayed on saturated ground or just prior to a rain event to minimize runoff. Another factor in the application of the manure is pumping the lagoons often enough to avoid a lagoon overflow. Also, the waste is not land applied during the winter months when there is no forage or crop being grown. This manure is a potential contributor of bacteria to receiving water bodies due to runoff produced during a rain event.

Based on 2002 Census of Agriculture produced by the National Agriculture Statistics Service, there were approximately 14 farms in Lowndes County with an undisclosed number of hogs and pigs, and there were approximately 25,184 hogs and pigs on 22 farms in Noxubee County (USDA, 2004). Of the 14 farms in Lowndes County, 10 have less than 24 hogs and pigs and 2 have greater than 1,000 hogs and pigs. Of the 22 farms in Noxubee County 5 farms have greater than 1,000 hogs and pigs, 5 farms have between 500 and 999 hogs and pigs and the remaining 12 farms have less than 24 hogs and pigs each. There are two hog processing facilities with no discharge NPDES General Permits located in the upper part of the watershed. These are Mullet Farms (Mississippi CAFO permit number MSG160002); and Paul Graber Swine Facility (Mississippi CAFO permit number MSG160042), both with spray irrigation wastewater treatment (see Figure 3).

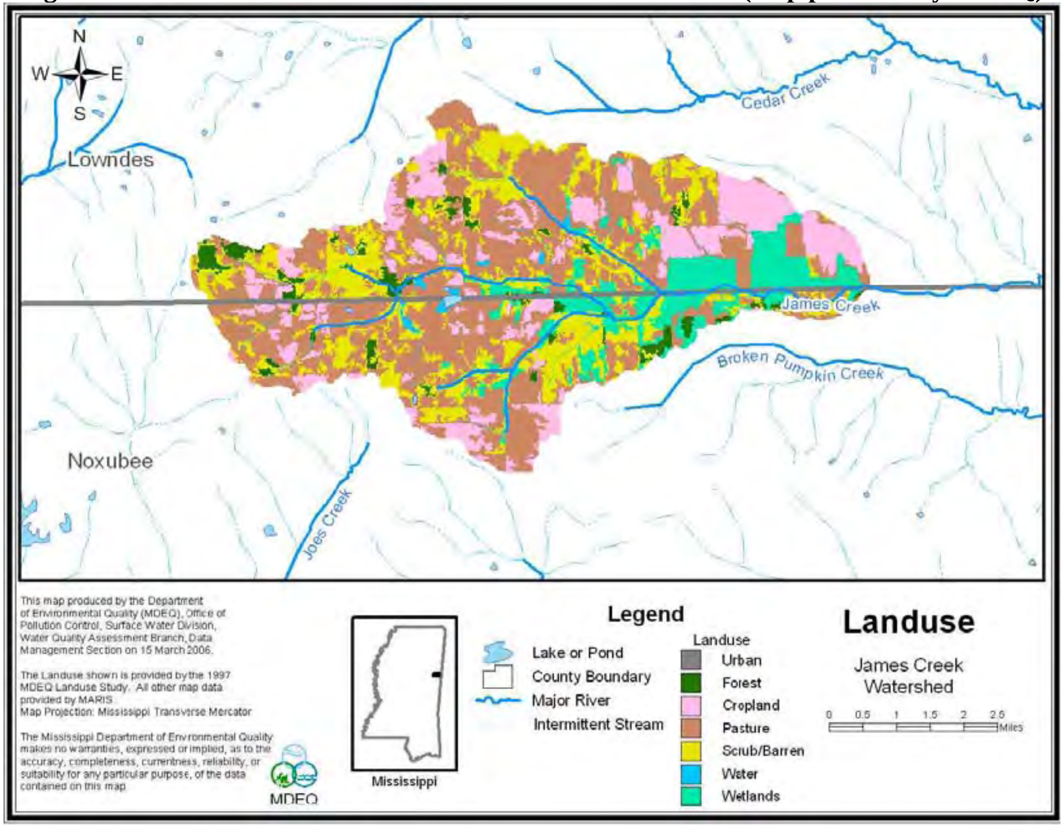
Figure 3. Map of CAFOs in the James Creek Watershed (map provided by MDEQ)



3.2 Assessment of Nonpoint Sources

Typical nonpoint sources of fecal coliform include wildlife, agricultural animals, septic tanks, and urban development outside of MS4 areas. Nonpoint source pollutant loads typically occur in response to rain events, but animals having access to streams and leaking septic tanks can result in nonpoint source loads during dry weather conditions. Based on landuse information provided in Table 1, the categories most likely associated with the non-point source discharges of fecal coliform in the James Creek watershed would be agriculture, including animals having access to streams. Agriculture landuse comprises 45 percent of the watershed. A general discussion of septic tanks and the impact malfunctioning ones have on water quality is included in this source assessment, but are not considered a significant source due to the negligible amount of urban landuse in the watershed (see Figure 4).

Figure 4. Landuse Distribution in the James Creek Watershed (map provided by MDEQ)



3.3 Wildlife

Wildlife deposit bacteria in their feces onto land surfaces where it can be transported during storm events to nearby streams. Bacteria load from wildlife is assumed background, since this source is considered "natural" when compared to the loading from agriculture. Water fowl (e.g., egrets, ducks, wood storks, herons) often frequent stormwater ponds and wetland areas surrounding the creek.

3.4 Agricultural Animals

Agricultural animals are the source of several types of coliform loadings to streams that impact water quality. This source includes agriculture runoff from pastures and cattle in streams. Landuse within the James Creek watershed is predominately agricultural, so this landuse likely produces a significant amount of the bacteria load. Grazing cattle deposit manure on pastureland where it is available for wash-off and delivery to receiving water bodies. Beef cattle have access to pastureland for grazing all of the time. For dairy cattle, the dry cattle and heifers have access to pastureland for grazing all of the time. Manure produced by grazing beef and dairy cows is directly deposited onto pastureland and is available for wash off.

Large dairy farms, over 200 head, typically confine the milking herd at all times. Small dairy farms confine the lactating cattle for a limited time during the day for milking and feeding. The manure collected during confinement is applied to the available pastureland in the watershed. Application rates of dairy cow manure to pastureland vary monthly according to management practices currently used in this area. Based on 2002 Census of Agriculture, there were approximately 12,753 cattle on 188 farms in Lowndes County, and approximately 17,108 cattle on 244 farms in Noxubee County (USDA, 2004). Only about 6.2% of the farms are large farms with over 200 head of cattle. These cattle are primarily beef cattle, heifers, steers, and bulls. In Noxubee Counties there are less than 15 farms which have approximately 1,908 dairy cows. The majority of these cows are on small farms with less than 200 head of cattle, with only four farms having greater than 200 head. In Lowndes County, there are only 3 farms with 24 dairy cows all together.

3.5 Failing Septic Systems

Septic systems have a potential to deliver fecal coliform bacteria loads to surface waters due to malfunctions, failures, and direct pipe discharges. Properly operating septic systems treat wastewater and dispose of the water through a series of underground field lines. The water is applied through these lines into a rock substrate, thence into underground absorption. The systems can fail when the field lines are broken, or when the underground substrate is clogged or flooded. A failing septic system's discharge can reach the surface, where it becomes available for wash-off into the stream. Another potential problem is a direct bypass from the system to a stream. In an effort to keep the water off the land, pipes are occasionally placed from the septic tank or the field lines directly to the creek.

Another consideration is the use of individual onsite wastewater treatment plants. These treatment systems are in wide use in Mississippi. They can adequately treat wastewater when properly maintained. However, these systems may not receive the maintenance needed for proper, long-term operation. These systems require some sort of disinfection to properly operate.

When this expense is ignored, the water does not receive adequate disinfection prior to release. The watershed contains several facilities that operate onsite wastewater treatment plants. All septic systems may have an impact on nonpoint source fecal coliform impairment in the Tombigbee River Basin. The best management practices needed to reduce this pollutant load need to prioritize eliminating septic tank failures and improving maintenance and proper use of individual onsite treatment systems. Some counties in Mississippi manage the problem of onsite treatment systems through the use of a wastewater ordinance. A wastewater ordinance requires that the wastewater treatment and disposal system used be certified as sufficient. It also ensures that electricity, water, or natural gas will not be made available until written approval from the county Health Department or the MDEQ has been received stating that the system used is sufficient. The lack of a wastewater ordinance could allow some of the rural areas to have only modest wastewater treatment, if any treatment, before discharge.

3.6 Urban Development

Fecal coliform loading from urban areas is attributable to multiple sources including stormwater runoff, leaks and overflows from sanitary sewer systems, if present, illicit discharges of sanitary waste, and domestic animals. Based on the landuse distribution in the watershed, there are no significant areas of urban development in the watershed. The contribution of fecal coliform loadings from farms and other rural areas is considered minor relative to the loadings from agriculture.

4.0 ANALYTICAL APPROACH

The approach for calculating coliform TMDLs depends on the number of water quality samples and the availability of flow data. When long-term records of water quality and flow data are not available, as is the case for James Creek, the TMDL is expressed as a percent reduction. The reduction is based on the 90th percentile concentration violating the not to exceed 10% criteria.

The TMDL is expressed as a daily load by multiplying the water quality target by an estimate of flow in James Creek. A weighted drainage area approach is used to estimate flow in James Creek. In this approach, flow at an ungaged site is calculated by multiplying flow measured at a gaged site by the drainage area ratio of the two sites. A weighted drainage approach is an appropriate method to calculate flow when the two watersheds are of similar size and land use distributions. The USGS gage located on the Cedar Creek near Trinity, MS (USGS 02443710) is used to estimate flow in James Creek (see Figure 5). Figure 6 shows the location of the fecal station on James Creek as well as the Cedar Creek gage site.

Figure 5. Gauge Site Location on Cedar Creek (map provided by MDEQ)

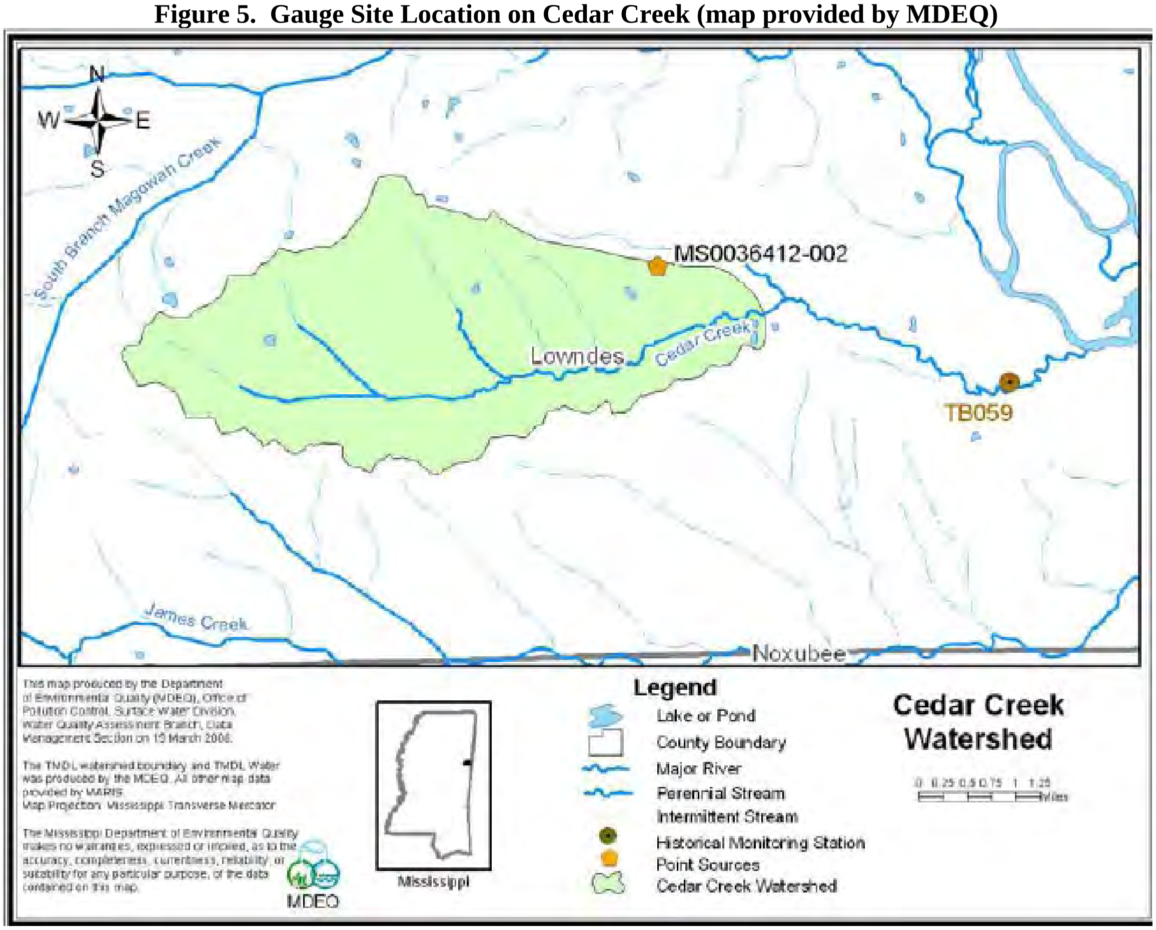


Figure 6. Location of James Creek Fecal Station and Cedar Creek Gage (map provided by MDEQ)

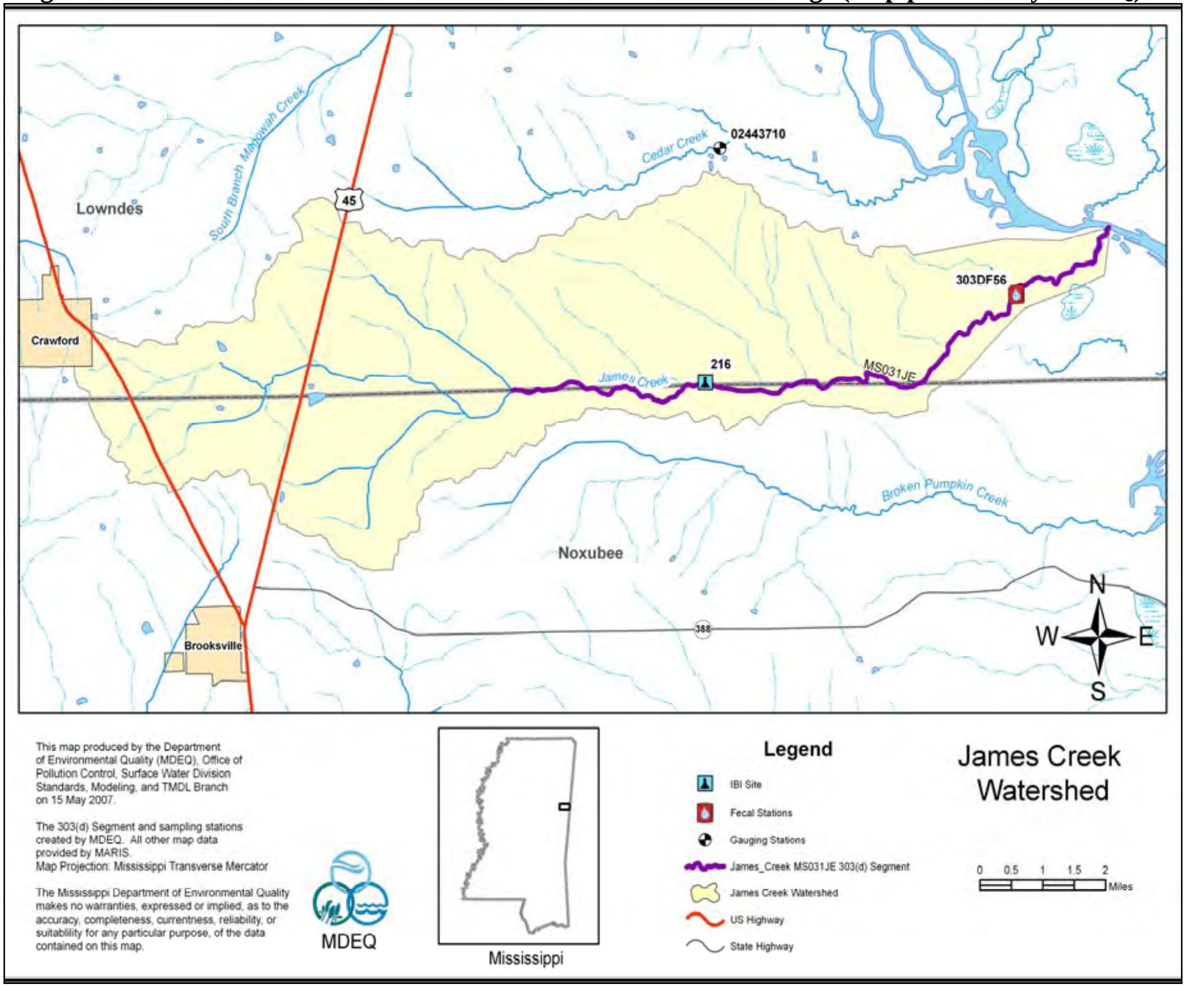


Table 7. Landuse and land cover data as percentages for the Cedar Creek watershed and riparian zones

Landuse Land Cover	Entire Watershed (EW)		100m Buffer EW		100m Buffer 1km radius	
	Acres	%area	Acres	%area	Acres	%area
Urban	0	0%	0	0%	0	0%
Forest	279	4%	140	13%	34	56%
Cropland	592	8%	30	3%	0	0%
Pasture/Grassland	3609	49%	350	32%	1	2%
Scrub/Barren	1750	24%	325	29%	12	20%
Water	66	1%	16	1%	0	0%
Wetland	1057	14%	250	22%	13	22%
Total	**7354**	**100%**	**1112**	**100%**	**62**	**100%**

Table 8. Landuse and land cover data as percentages for the James Creek watershed and riparian zones

Landuse Land Cover	Entire Watershed (EW)		100m Buffer EW		100m Buffer 1km radius	
	Acres	%area	Acres	%area	Acres	%area
Urban	0	0%	0	0%	0	0%
Forest	673	4%	154	5%	2	3%
Cropland	2868	16%	171	5%	0	0%
Pasture/Grassland	8270	45%	1206	38%	19	25%
Scrub/Barren	4110	22%	935	29%	10	13%
Water	113	1%	36	1%	0	0%
Wetland	2269	12%	692	22%	46	60%
Total	**18302**	**100%**	**3194**	**100%**	**78**	**100%**

The drainage area at the Cedar Creek gage is about 11.5 square miles, while the drainage area of James Creek is 45.75 square miles. Land use in both watersheds is predominately pasture lands (see **Error! Reference source not found.** and Table 8). The drainage area ratio of James Creek and the Cedar Creek is 3.98 (i.e., 45.75/11.5= 3.98). Based on flow measurements recorded at the USGS gage from 1979-1982, the mean flow in Cedar Creek for the summer months (May-October) was estimated to be 1.63 cfs. Although the period of record at the USGS gage is only three years, the flow records were used to estimate seasonal flows in James Creek. These flows were used to calculate daily loads for James Creek. The TMDL also presents percent reductions for the summer and winter seasons. The reductions were calculated based on measured concentrations and not loads. The percent reductions can be implemented through BMPs.

The mean flow in Cedar Creek for the winter months (November-April) was estimated to be 22.78 cfs. The estimated flow and daily load in James Creek is calculated as follows:

Flow (ungaged site) = Flow (gage stream) * (area of ungaged site/area of gage sited)
Summer Flow James Creek = 1.63 cfs * (45.75/11.5) = 6.49 cfs
Winter Flow James Creek = 22.78 cfs * (45.75/11.5) = 90.66 cfs

Summer Load (counts/day) = 6.49 cfs * 400 counts/100ml * (28317 ml/cubic ft *86400 sec/day)
Summer Load (counts/day) = 6.35×10^{10}

Winter Load (counts/day) = 90.66 cfs * 4000 counts/100ml * (28317 ml/cubic ft *86400 sec/day)
Winter Load (counts/day) = 8.87×10^{12}

4.1 Development of Total Maximum Daily Loads

The TMDL process quantifies the amount of a pollutant that can be assimilated in a water body, identifies the sources of the pollutant, and recommends regulatory or other actions to be taken to achieve compliance with applicable water quality standards based on the relationship between pollution sources and in-stream water quality conditions. A TMDL can be expressed as the sum of all point source loads (WLA), nonpoint source loads (LA), and an appropriate margin of safety (MOS), which takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

$$TMDL = \Sigma\ WLAs + \Sigma\ LAs + MOS$$

The objective of a TMDL is to allocate loads among all of the known pollutant sources throughout a watershed so that appropriate control measures can be implemented and water quality standards achieved. 40 CFR §130.2 (i) states that TMDLs can be expressed in terms of mass per time (e.g. pounds per day), toxicity, or other appropriate measures. The TMDL for James Creek is expressed in terms of a daily load and a percent reduction. The percent reduction is based on the 90th percentile concentration exceeding the water quality target of 400 counts/100ml in the summer. Best management practices (BMPs) that achieve the prescribed percent reduction should be used to implement the TMDL.

4.2 Critical Conditions

The critical condition for non-point source coliform loading is an extended dry period followed by a rainfall runoff event. During the dry weather period, coliforms build up on the land surface, and are washed off by rainfall. The critical condition for point source loading occurs during periods of low stream flow when dilution is minimized. Critical conditions are accounted for in the TMDL by using the 90th percentile concentration calculated for the summer season. By meeting water quality standards with this value, standards should be met for all other coliform criteria.

4.3 Margin of Safety

There are two methods for incorporating a MOS in the analysis: a) implicitly incorporate the MOS using conservative model assumptions to develop allocations; or b) explicitly specify a portion of the TMDL as the MOS and use the remainder for allocations. In the James Creek TMDL an explicit MOS was used, which equals 10% of the TMDL value.

4.4 Determination of TMDL Components

The TMDL components are expressed as percent reductions necessary to maintain water quality standards and as a daily load. The TMDL value is reduced by the MOS and WLA, if any, to obtain the LA component. TMDL components are shown in Table 9.

There are no wastewater or MS4 NPDES permitted facilities discharging fecal coliform to James Creek. CAFOs located in the watershed have a zero discharge permit, and if they operate in accordance with their permit they should not cause or contribute fecal coliform to James Creek; therefore, the WLA is equal to zero. Any future facility permitted to discharge fecal coliform bacteria in the watershed will be required to meet permit limits. Future facilities discharging at concentrations less than the water quality standard should not cause or contribute fecal coliform bacteria impairment in the watershed.

The reduction prescribed for the LA is based on the following equation:

Reduction = [(90th percentile concentration – target)/90th percentile concentration] * 100

The percent reduction assigned to the summer season LA component is calculated using the 90th percentile concentration of 716 counts/100ml measured in May 2002. There were no violations of the winter coliform water quality standards and therefore, no reduction is needed during the winter season. The percent reduction from current conditions is as follows:

Summer Reduction = [(716 – 400) / 716)] *100 = 44.1 %

Table 9. TMDL Components for James Creek

Season	WLA (counts/day)	LA (counts/day)	MOS	TMDL (counts/day)	Percent Reduction
Summer	0	5.715×10^{10}	6.35×10^{9}	6.35×10^{10}	44.1%
Winter	0	7.983×10^{12}	8.87×10^{11}	8.87×10^{12}	0%

Note: In the absence of NPDES discharges the percent reduction applies to the LA component.

4.5 Seasonal Variation

For many streams in Mississippi, fecal coliform limits vary according to the seasons. This stream is designated for the use of secondary contact. For this use, the fecal coliform standard is seasonal. The criterion for the most critical season, which is the summer for James Creek, was used as the target for this TMDL. EPA used the average summer flow for calculating the summer TMDL and the average winter flow for calculating the winter TMDL. Therefore, the seasonal differences are incorporated in the seasonal average flow values.

5.0 CONCLUSION

Any future facility permitted to discharge fecal coliform bacteria in the watershed will be required to meet permit limits. Future facilities discharging at concentrations less than the water quality standard should not cause or contribute fecal coliform bacteria impairment in the watershed. Education projects that teach best management practices should be used as a tool for reducing nonpoint source contributions of bacteria to the James Creek watershed.

5.1 Future Monitoring

MDEQ has adopted the Basin Approach to Water Quality Management, a plan that divides Mississippi's major drainage basins into five groups. During each year long cycle, MDEQ resources for water quality monitoring will be focused on one of the basin groups. During the next monitoring phase in the Tombigbee River Basin, it may be possible for James Creek to receive additional monitoring to identify any change in water quality.

5.2 Public Participation

This draft TMDL is being proposed for public review and comment for a 30-day period. The EPA is notifying the public by publishing a notice of the TMDL through a legal ad in the statewide newspaper, the *Clarion-Ledger*. EPA is also providing notice to members of the public through e-mail who have requested that MDEQ include them on a TMDL mailing list. The TMDL is also available for review and comment on EPA Region 4's website:
(http://www.epa.gov/Region4/water/tmdl/mississippi/).
The public may request to receive the TMDL report through the mail by addressing their comments to:

Attention: Ms Sibyl Cole,
U.S. EPA Region 4, Water Management Division
61 Forsyth Street, S.W.
Atlanta, Georgia 30303

The public may also submit comments by email at cole.sibyl@epa.gov or by phone at 404-562-9437. All comments received during the public notice period will become a part of the public record for this TMDL.

REFERENCES

MDEQ. 2006. Mississippi List of Water Bodies, Pursuant to Section 303(d) of the Clean Water Act. Office of Pollution Control.

MDEQ. 2003. State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters. Office of Pollution Control.

MDEQ. 2002. State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters. Office of Pollution Control. Jackson, MS.

USDA. 2004. 2002 Census of Agriculture. U.S. Department of Agriculture, National Agricultural Statistics Service, Washington, D.C.

DEFINITIONS

Ambient stations: a network of fixed monitoring stations established for systematic water quality sampling at regular intervals, and for uniform parametric coverage over a long-term period.

Assimilative capacity: the capacity of a natural body of water to receive wastewaters or toxic materials without deleterious effects and without damage to aquatic life or humans who use the water.

Background: the condition of waters in the absence of man-induced alterations based on the best scientific information available to MDEQ. The establishment of natural background for an altered water body may be based upon a similar, unaltered or least impaired, water body or on historical pre-alteration data.

Best Management Practices (BMPs): (1) The methods, measures, or practices selected by an agency to meet its nonpoint source control needs. BMPs include but are not limited to structural and nonstructural controls and operation and maintenance procedures. BMPs can be applied before, during, or after pollution-producing activities to reduce or eliminate the introduction of pollutants into receiving waters. (2) Methods have been determined to be the most effective, practical means of preventing or reducing pollution from nonpoint sources.

Calibrated model: a model in which reaction rates and inputs are significantly based on actual measurements using data from surveys on the receiving water body.

Critical Condition: The critical condition can be thought of as the "worst case" scenario of environmental conditions in the water body in which the loading expressed in the TMDL for the pollutant of concern will continue to meet water quality standards. Critical conditions are the combination of environmental factors (e.g., flow, temperature, etc.) that results in attaining and maintaining the water quality criterion and has an acceptably low frequency of occurrence.

Daily discharge: the discharge of a pollutant measured during a 24-hour period that reasonably represents the day for purposes of sampling. For pollutants with limitations expressed in units of mass, the daily discharge is calculated as the total mass of the pollutant discharged over the day. For pollutants with limitations expressed in other units of measurement, the daily discharge is calculated as the average measurement of the pollutant over the day.

Designated Uses: (1) those uses specified in the water quality standards for each water body or segment whether or not they are being attained. (2) those water uses identified in state water quality standards which must be achieved and maintained as required under the Clean Water Act. Uses can include public water supply, recreation, etc.

Discharge monitoring report (DMR): the EPA uniform national form, including any subsequent additions, revisions, or modifications for the reporting of self-monitoring results by permittees.

Effluent: wastewater – treated or untreated – that flows out of a treatment plant or industrial outfall. Generally refers to wastes discharged into surface waters.

Effluent limitation: (1) any restriction established by a State or the Administrator on quantities, rates, and concentrations of chemical, physical, biological, and other constituents which are discharged from point sources into navigable waters, the waters of the contiguous zone, or the ocean, including schedules of compliance. (2) restrictions established by a State or EPA on quantities, rates, and concentrations in wastewater discharges.

Effluent standard: any effluent standard or limitation, which may include a prohibition of any discharge, established or proposed to be established for any toxic pollutant under section 307(a) of the Act.

Fecal Coliform Bacteria: (1) those organisms associated with the intestines of warm-blooded animals that are commonly used to indicate the presence of fecal material and the potential presence of organisms capable of causing human disease (2) bacteria found in the intestinal tracts of mammals. Their presence in water or sludge is an indicator of pollution and possible contamination by pathogens.

Geometric mean: the nth root of the production of n factors. A 30-day geometric mean is the 30th root of the product of 30 numbers.

Impaired Water Body: any water body that does not attain water quality standards due to an individual pollutant, multiple pollutants, pollution, or an unknown cause of impairment.

Land Surface Runoff: water that flows into the receiving stream after application by rainfall or irrigation. It is a transport method for nonpoint source pollution from the land surface to the receiving stream.

Load allocation (LA): the portion of receiving water's loading capacity that is attributed either to one of its existing or future nonpoint sources of pollution or to natural background sources. Load allocations are best estimates of the loading, which may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading. Wherever possible, natural and nonpoint source loads should be distinguished.

Loading: the introduction of waste into a waste management unit but not necessarily to complete capacity.

Mass Balance: a concept based on a fundamental law of physical science (conservation of mass) which says that matter can not be created or destroyed. It is used to calculate all input and output streams of a given substance in a system.

Model: a quantitative or mathematical representation or computer simulation which attempts to describe the characteristics or relationships of physical events.

National pollutant discharge elimination system (NPDES): the national program for issuing, modifying, revoking and reissuing, terminating, monitoring and enforcing permits, and imposing and enforcing pretreatment requirements, under section 307, 402, 318, and 405 of the Clean Water Act.

Nonpoint Source: the pollution sources which generally are not controlled by establishing effluent limitations under section 301, 302, and 402 of the Clean Water Act. Nonpoint source pollutants are not traceable to a discrete identifiable origin, but generally result from land runoff, precipitation, drainage, or seepage.

Outfall: the point where an effluent is discharges into receiving waters

Point Source: a stationery location or fixed facility from which pollutants are discharges or emitted. Also, any single identifiable source of pollution, e.g., a pipe, ditch, ship, ore pit, factory smokestack.

Pollution: generally, the presence of matter or energy whose nature, location or quantity produces undesired environmental effects. Under the Clean Water Act, for example, the term is defined as the man-made or man-induced alteration of the physical, biological, and radiological integrity of water.

Publicly Owned Treatment Works (POTW): the treatment works treating domestic sewage that is owned by a municipality or State.

Scientific Notation (Exponential Notation): mathematical method in which very large numbers or very small numbers are expressed in a more concise form. The notation is based on powers of ten. Numbers in scientific notation are expressed as the following: $4.16 \times 10^{(+b)}$ and $4.16 \times 10^{(-b)}$ [same as 4.16E4 or4.16E-4]. In this case, b is always a positive, real number. The $10^{(+b)}$ tells us that the decimal point is b places to the right of where it is shown. The $10^{(-b)}$ tells us that the decimal point is b places to the left of where it is shown. For example: 2.7X104 = 2.7E+4 =27000 and 2.7X10-4 = 2.7E-4=0.00027. Sigma (Σ): shorthand way to express taking the sum of a series of numbers. For example, the sum or total of three amounts 24, 123, 16, (dl, d2, d3) respectively could be shown as: $\sum_{i=1}^{3} d_i = d_1+d_2+d_3 = 24+123+16 = 163$

Total Maximum Daily Load or TMDL: (1) the calculated maximum permissible pollutant loading introduced to a water body such that any additional loading will produce a violation of water quality standards. (2) the sum of the individual waste load allocations and load allocations. A margin of safety is included with the two types of allocations so that any additional loading, regardless of source, would not produce a violation of water quality standards.

Waste: (1) useless, unwanted or discarded material resulting form (agricultural, commercial, community and industrial) activities. Wastes include solids, liquids, and gases. (2) any liquid resulting from industrial, commercial, mining, or agricultural operations, or from community activities that is discarded or is being accumulated, stored, or physically, chemically, or biologically treated prior to being discarded or recycled.

Wasteload allocation (WLA): (1) the portion of a receiving water's loading capacity that is allocated to one of its existing or future point sources of pollution. WLAs constitute a type of water quality based effluent limitation. (2) the portion of a receiving water's total maximum daily load that is allocated to one of its existing or future point source of pollution. (3) the maximum load of pollutants each discharger of waste is allowed to release into a particular waterway. Discharge limits are usually required for each specific water quality criterion being, or expected to be, violated. The portion of a stream's total assimilative capacity assigned to an individual discharge.

Water Quality Standards: State-adopted and EPA-approved regulations mandated by the Clean Water Act and specified in 40 CFR 131 that describe the designated uses of a water body, the numeric and narrative water quality criteria designed to protect those uses, and an antidegredation statement to protect existing levels of water quality. Standards are designed to safeguard the public health and welfare, enhance the quality of water and serve the purposes of the Clean Water Act.

Water quality criteria: numeric water quality values and narrative statements which are derived to protect designated uses. Numeric criteria are scientifically-derived ambient concentrations developed by EPA or States for various pollutants of concern to protect human health and aquatic life. Narrative criteria are statements that describe the desired water quality goal. Ambient waters that meet applicable water quality criteria are considered to support their designated uses.

Waters of the State: all waters within the jurisdiction of this State, including all streams, lakes, ponds, wetlands, impounding reservoirs, marshes, watercourses, waterways, wells, springs, irrigation systems, drainage systems, and all other bodies or accumulations of water, surface and underground, natural or artificial, situated wholly or partly within or bordering upon the State, and such coastal waters as are within the jurisdiction of the State, except lakes, ponds, or other surface waters which are wholly landlocked and privately owned, and which are not regulated under the Federal Clean Water Act (33 U.S.C.1252 et seq.).

Watershed: (1) the land area that drains (contributes runoff) into a stream. (2) the land area that drains into a stream; the watershed for a major river may encompass a number of smaller watersheds that ultimately combine at a common delivery point.

ABBREVIATIONS

BMP	Best Management Practice
CWA	Clean Water Act
DMR	Discharge Monitoring Report
EPA	Environmental Protection Agency
GIS	Geographic Information System
HCR	Hydrograph Controlled Release
HUC	Hydrologic Unit Code
LA	Load Allocation
MARIS	Mississippi Automated Resource Information System
MDEQ	Mississippi Department of Environmental Quality
MOS	Margin of Safety
NRCS	National Resource Conservation Service
NPDES	National Pollution Discharge Elimination System
UNT	Unnamed Tributary
USGS	United States Geological Survey
WLA	Waste Load Allocation